Jack Halpern (1925–2018): Pioneer of homogeneous catalysis

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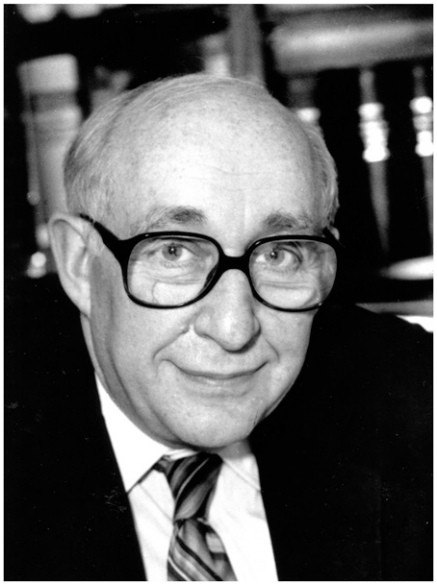
Jack Halpern, a preeminent scholar and father of modern organometallic chemistry and homogeneous catalysis, died January 31, 2018 at the age of 93. Homogeneous catalysis by transition metal complexes, a field that has many important scientific and technological applications, can be traced to his early contributions. Jack developed methodologies to investigate the mechanisms and thermodynamics of fundamental chemical transformations that underpin organometallic and bioinorganic chemistry. Perhaps most notably, he reported the first molecular catalyst for hydrogenation of olefins and later elucidated the principles of catalytic asymmetric hydrogenation of olefins. Halpern helped, more so than any other chemist, to define the intellectual basis of modern catalytic science.

Jack Halpern, emeritus Louis Block Professor of Chemistry at the University of Chicago, was born in Poland and moved to Montreal at age 4. After completing his Bachelor of Science and doctorate studies with Carl Winkler at McGill, Halpern undertook a National Research Council Overseas Postdoctoral Fellowship with A. G. Evans at Manchester University, in the United Kingdom. In 1950 Jack joined the department of metallurgy and mining (not chemistry!) at the University of British Columbia, and his attention soon turned to the mechanisms of dissolution of copper and silver. In 1954 Jack published the first of a series of papers describing the reactions of cupric acetate with dihydrogen (H_2) (1). His mechanistic investigations implicated a copper hydride intermediate, the earliest evidence for a metal hydride complex in reactions of metal ions with dihydrogen. In 1961 Jack and his research group developed the first homogeneous transition metal catalyst, a ruthenium complex, for hydrogenation of olefins.

After his move to the University of Chicago in 1962, Jack undertook studies of many of the fundamental steps that comprise organotransition metal chemistry: oxidative addition, reductive elimination, migratory insertion, and ligand substitution. This body of work and his recognition of the relationships between metal- and organic-based reactivity (later generalized by Roald Hoffmann as "isolobal analogies") were foremost in the growth of the new field. Jack admonished chemists to include studies of kinetics in their investigations of mechanism; only then can one establish the existence and nature of fleeting intermediates. A dramatic vindication of Jack's tenet ("if you can identify a compound from a catalytic system, it is probably *not* the catalyst") was his elegant demonstration that in the rhodium-catalyzed asymmetric hydrogenation of olefins, it is not the preferred mode of initial binding of the prochiral substrate to the chiral catalyst, but rather the much higher reactivity of the minor, less stable diastereomeric catalyst–substrate complex with H_2 that governs the enantioselectivity of the overall catalytic reaction. His findings raised significant questions about the validity of some widely accepted "lock and key" interpretations of other asymmetric catalytic reactions, including those for certain enzymatic catalysts. Jack also carried out work in the budding field of bioinorganic chemistry by clarifying the functions of vitamin B_{12} (an organocobalt enzyme) and of hydrogenases that catalyze dihydrogen reduction of one-electron oxidants.



Jack Halpern. Image courtesy of National Academy of Sciences.

Jack's mentoring style was first made evident to me as a new postdoctoral fellow in his research group. While carrying out research in the laboratory I noticed that Jack was making rounds inquiring about the progress of each group member. He approached me and asked, "How is it going?" I replied that my project was proceeding very well. Jack looked at me silently, then

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Author contributions: J.E.B. wrote the paper.
The author declares no conflict of interest.

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Published online April 25, 2018.

moved on to the next group member after 15 seconds. After his departure, I realized that I was supposed to have said much more! The next time Jack made rounds I was ready for him. Jack and I enjoyed a wonderful hour discussing at the blackboard in the laboratory, the details of my kinetics measurements, and what they might indicate about the mechanism of the cobalt-catalyzed oxidation of carbon monoxide to carbon dioxide. After that encounter I regularly visited his office to seek his broad knowledge and wisdom concerning my project. He was always receptive at these unscheduled interruptions and clearly loved discussing science with me. During that year, Jack and I developed a friendship of mutual admiration and respect that I have always cherished.

In addition to his research activities, Jack found ways to serve the scientific community: 25 years as associate editor for the *Journal of the American Chemical Society*, an editor for the *Proceedings of the National Academy of Sciences* (striving fervently for increasing the number of articles in the physical sciences), service as Vice President of the National Academy of Sciences, and a member of many advisory boards. He was a treasured consultant at Monsanto and Argonne National Laboratory.

Jack's enthusiasm for science was equaled by his passion for the arts. He and his wife Helen, who died in 2011, were collectors of 20th century art. Attending a research group dinner party at their home was like visiting an elegant museum. Jack served on the Board of Directors on the University of Chicago's Court Theater and Smart Museum of Art, and he and Helen were regular attendees at the Chicago Symphony Orchestra and Lyric Opera.

Over his career Jack nurtured the field of catalysis by inorganic and organometallic complexes from its infancy to its present state of maturity and widespread importance. His perceptive mind and love of a scholarly debate often led to lively exchanges at seminars and conferences. Invariably seated in the front row, Jack's hand would shoot up at lecture's end, and then he would proclaim "I have a comment and a question." I admired Jack's enthusiasm, his skill in such debates, and most of all his respect and affection for all he engaged.

1 Dackers RG, Halpern J (1954) Kinetics of the homogenous reaction between cupric acetate and molecular hydrogen in aqueous solution. *Can J Chem* 32:969–978.